A 2,300-year-old architectural and astronomical complex in the Chincha Valley, Peru

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Recent archaeological research on the south coast of Peru discovered a Late Paracas (ca. 400–100 BCE) mound and geoglyph complex in the middle Chincha Valley. This complex consists of linear geoglyphs, circular rock features, ceremonial mounds, and settlements spread over a 40-km^2 area. A striking feature of this culturally modified landscape is that the geoglyph lines converge on mounds and habitation sites to form discrete clusters. Likewise, these clusters contain a number of paired line segments and at least two U-shaped structures that marked the setting sun of the June solstice in antiquity. Excavations in three mounds confirm that they were built in Late Paracas times. The Chincha complex therefore predates the better-known Nasca lines to the south by several centuries and provides insight into the development and use of geoglyphs and platform mounds in Paracas society. The data presented here indicate that Paracas peoples engineered a carefully structured, ritualized landscape to demarcate areas and times for key ritual and social activities.

chiefdoms | Andean

The Chincha Valley, located 200 km south of Lima, was one of the largest and most productive regions of southern coastal Peru (Fig. 1). Previous research identified a rich prehispanic history in the valley, beginning at least in the early first millennium BCE and continuing through the Inca period in the 16th century CE (1–3). The earliest settled villages were part of the Paracas culture, a widespread political and social entity that began around 800 BCE and continued up to around 100 BCE. Previous field surveys identified at least 30 major Paracas period sites in the valley (1, 3, 4), making Chincha one of the main centers of development for this early Andean civilization (5). As such, it is an ideal area to test models of social evolution in general and to define the strategies that early peoples used to construct complex social organizations within the opportunities and constraints provided by their environments.

Previous research demonstrated a dense Paracas settlement in the lower valley that focused on large platform mound complexes (Fig. 2) (4, 6). Three seasons of systematic, intensive survey and excavations by our team confirm the existence of a rich and complex Paracas occupation in the midvalley area as well, including both mound clusters and associated geoglyph features. In short, our data indicate that (*i*): the Chincha geoglyphs predate the better-known Nasca drainage ones by at least three centuries; (*ii*) Paracas period peoples created a complex landscape by constructing linear geoglyphs that converge on key settlements; and (*iii*) solstice marking was one component underlying the logic of geoglyph and platform mound construction and use in the Chincha Valley during the Paracas period.

Methods

Survey. The research area was identified from previous work that documented a number of platform mounds in the middle Chincha Valley (1, 4, 7, 8). We intensively surveyed 30 km^2 in the desert pampas above and to the east of these sites. All archaeological features—geoglyphs, stone circles, platforms, and cairns—were recorded in the field with multiple global positioning system (GPS) readings. We plotted and ground checked all significant features. We used hand-drafted and digitally generated models of the survey data to identify feature clusters, possible ray centers, and sets of associated or parallel geoglyphs. These data were then entered into a valley-wide survey database to compare important geoglyph features with known Paracas period sites.

Excavations. Based on the survey, we selected three test units at the site of Chococota, also known as PV57-63 or "Mono," a site framed by multiple sets of linear geoglyphs. We excavated to sterile bedrock, a 2 × 2 m unit in the southern arm of a U-shaped mound ("Mono B") and a 2 × 2 m unit in one platform mound ("Mono C1"). We cleaned and excavated to sterile bedrock, a disturbed profile in the large platform mound ("Mono A") (Figs. S1–S3).

Carbon Dating. All dates were taken on noncarbonized annual plant remains, mainly maize and reed leaves or stalks. Each of these samples came from stratified, sealed contexts. The samples were all processed at the Keck Accelerator Mass Spectrometry (AMS) laboratory at the University of California, Irvine.

Astronomical Orientations. Alignments for the Southern Hemisphere solstice 2,300 y before present were calculated using Starry Night Pro software. Orientations for the geoglyphs were independently confirmed by multiple GPS ground measurements and confirmed with hand compasses. The June solstice has moved only slightly (1/5 of a degree) in the last 3,000 y. In the Chincha Valley, it occurs at 294° azimuth. This shift over the millennia is imperceptible to the naked eye. We were therefore able to confirm the astronomical alignments through direct field observations during the June solstice of 2012 and that of 2013 (Fig. S4). Taking into account elevation changes and line-of-sight differences across the landscape, the solstice is observed between 293° and 295°.

Results

We documented 71 geoglyph lines/line segments and 353 non-geoglyph features (stone cairns, circles, and rectangular structures) in the study area (Fig. 3). We also identified a single ray center, the point of convergence for a series of lines or the

Significance

Recent archaeological discoveries on the south coast of Peru demonstrate that Paracas period peoples constructed a complex set of geoglyphs to mark ceremonial mounds and residential sites. Paracas societies in this region created a built or artificial landscape in an open desert to mediate periodic social events. Several of these architectural features were oriented to the sunset during the winter solstice. These data provide insight into the ways by which people in stateless societies organized their social, economic, and political life. Social units, labor, and astronomically significant periods mesh, attracting participants to cyclical events in the midvalley zone. This case study refines our understanding of the processes of human social evolution prior to the development of archaic states.

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Fig. 1. Map showing location of the Chincha Valley, southern coastal Peru.

central feature from which a series of linear geoglyphs diverges. The most striking aspect of the distribution of the geoglyphs is the degree to which the lines visually converge on known Paracas period platform mounds. As reconstructed by the projections seen in Fig. 4, there are four clusters around five known sites in the middle Chincha Valley (Fig. 4). All four clusters have a pair of lines or sets of paired lines that visually "frame" the major site from a distance (lines 221/222, 340/341, 122/123, 124/167, 162/164, and 107/108). The ancient technique was to build a pair of radiating lines in the form of a "V" that, at ground level from the apex of the lines, appear to be two straight lines due to perspective projection distortion. This technique was used to mark culturally significant features, specifically platform mounds and June solstice sunsets.

Three of four clusters contain long lines that mark the June solstice sunset at an orientation of 294° (lines 29–32, 124/167, 390, 451/452, and 319). Several of these lines also frame known Paracas platform mounds and sites. Line pair 29–32 frames site number PV57–60, a modern quarry from which we recorded late Paracas ceramics and in-situ domestic structures visible in profile cuts. The lines 124 and 167 frame site number PV57–64 (Pampa de Gentil) and also mark the June solstice. The area around site PV57–136 is so badly disturbed that numerous line segments have been destroyed, most likely obscuring a solstice marker. Additional line segments frame known Paracas sites in the midvalley cluster (site numbers PV57–59, –60, –63, –64, and –137), but do not appear to be solstice markers. Finally, all line clusters have large (4- to 12-m diameter) circular structures that allowed for enhanced viewing of the sites from a distance, particularly those that frame Paracas platform mounds (Fig. S5). Similar circular structures and cairn features are reported from Nasca and Palpa (9–11).

The mound group PV57–63, composed of five mounds, was intensively investigated (Fig. S6). We discovered at least 14 lines converging on the site area (Fig. 4). Three of these lines—319, 451, and 452—also mark the solstice. Two mounds with U-shaped architecture (B and C1) face the winter (June) solstice on the short axis. The largest platform mound structure of the site, Mono A, aligns with the solstice. We mapped and excavated at these three prominent structures to date the features and assess whether they had a domestic component. Excavations at PV57–63 yielded a statistically secure set of dates for each of the mounds tested (Table 1). The excavation data for each follow.

Mono A. This mound was originally recorded in the 1980s and divided into five sectors (8). It is clear that A1 and A2 formed

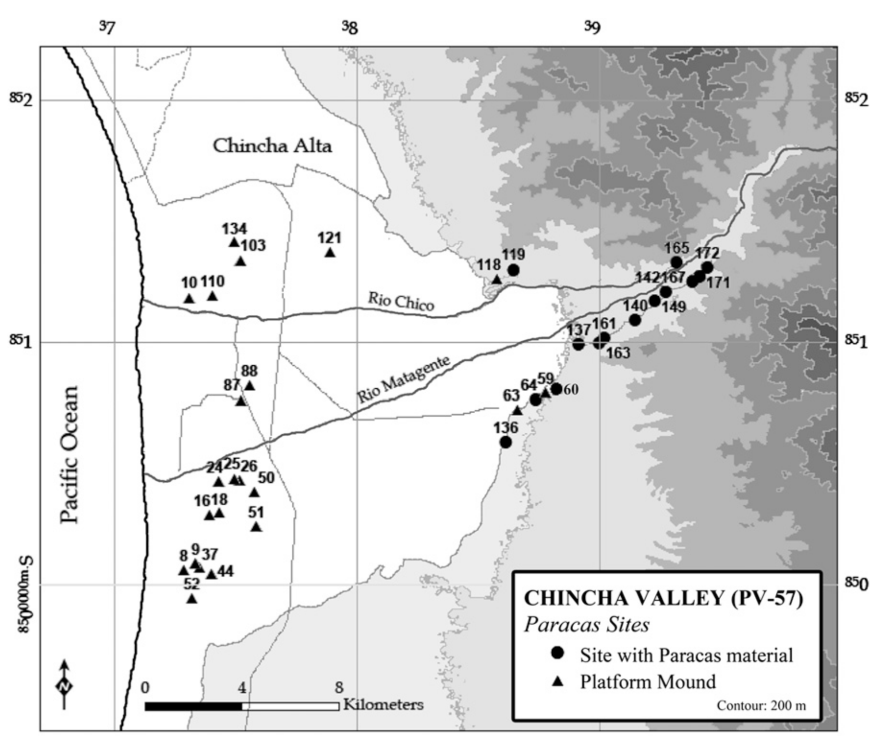

Fig. 2. Distribution of archaeological sites linked to Paracas period settlement in Chincha, Peru. Redrawn from Canziani (4).

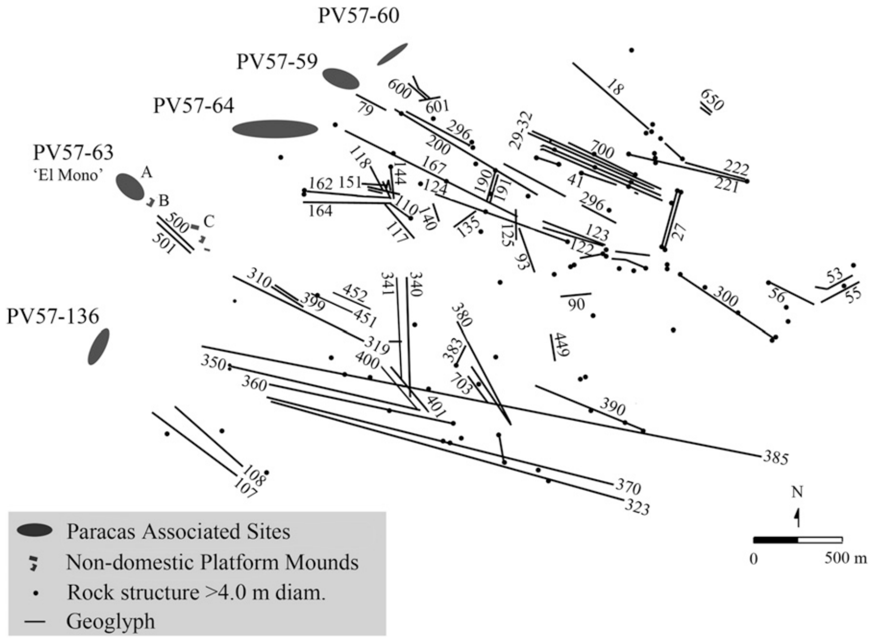

Fig. 3. Survey results showing known sites, recorded geoglyphs, and rock-pile features.

a single platform mound in antiquity, which was cut in half by earthmoving equipment during the last century. Mono A measures ~30 × 100 m with a height of at least 6 m. It has a triple platform/sunken patio construction similar to other Paracas period platform mounds in Chincha. Unlike these other mounds, which are cardinally oriented on an east–west axis (4), Mono A was aligned ~293° ± 2°. The long axis of the mound matches the azimuth position of the sunset during the June solstice. Modern construction has destroyed much of the mound, leaving several large cross-sections exposed. We located an intact profile composed of relatively clean fill with three visible construction episodes. We discovered vegetal matter at the base of each episode (Fig. S1). Carbon dates indicate that the upper layers of Mono A contain a post-Paracas occupation, made up of destroyed tombs. This later mortuary reuse lies above a single Paracas period construction episode, with a ≥0.95 probability that the structure was first built between 410 and 365 BCE (Table 1). There is a ≥0.83 probability that the last section of this mound, and therefore the entire structure, was completed at the same time. There is a light domestic component adjacent to the site away from the monumental architecture, as noted by our team and as recorded by earlier researchers (8).

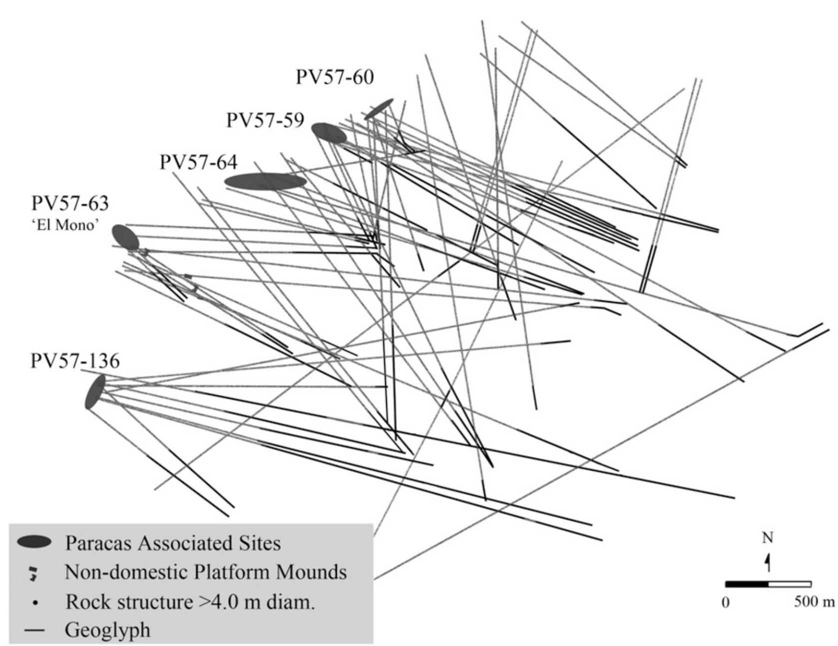

Fig. 4. Projection of recorded geoglyphs showing significant intersection with known Paracas period sites. Black segments indicate actual geoglyphs. Gray segments indicate projections.

Table 1. 14C dates from site PV57-63 ("mono" complex)

Laboratory no.	Reference no.	Provenience designation, cm	Submitter reference no.	δ13C (‰)	14C age, BP y	Calibrated ^{14}C age (cal AD/BC y)*
UCIAMS-131965	T-1064	A-73	2013–1	−10.4	660 ± 15	1305–1395 cal AD
UCIAMS-131966	T-1065	A-97	2013–2	−22.2	2,325 ± 15	400–355 cal BC (0.83)
						290–250 cal BC (0.16)
UCIAMS-131967	T-1066	A-112	2013–3	−24.5	2,345 ± 15	405–360 cal BC
UCIAMS-131968	T-1067	A-183	2013–4	−11.9	2,365 ± 15	410–365 cal BC
UCIAMS-131969	T-1068	B-48	2013–5	−9.3	2,240 ± 15	360–205 cal BC
UCIAMS-131970	T-1069	B-48	2013–6	−9.6	2,255 ± 15	365–210 cal BC
UCIAMS-131971	T-1070	B-62	2013–7	−23.1	2,245 ± 15	360–205 cal BC
UCIAMS-131972	T-1071	B-85	2013–8	−9.2	2,285 ± 15	390–345 cal BC (0.32)
						320–225 cal BC (0.65)
UCIAMS-131973	T-1072	C-40	2013–9	−25.2	2,335 ± 15	405–355 cal BC (0.92)
						285–255 cal BC (0.08)
UCIAMS-131974	T-1073	C-40	2013–10	−24.2	2,290 ± 20	395–345 cal BC (0.36)
						320–225 cal BC (0.61)
UCIAMS-131975	T-1074	C-55	2013–11	−18.0	2,305 ± 15	400–350 cal BC (0.57)
						300–230 cal BC (0.43)
UCIAMS-131976	T-1075	C-110	2013–12	−14.9	2,350 ± 20	410–355 cal BC
UCIAMS-131977	T-1076	C-110	2013–13	−12.0	2,335 ± 20	405–355 cal BC (0.87)
						290–250 cal BC (0.12)

*Calibration of the ^{14}C age for each measurement used CALIB 7.0 protocols using the SHcal13 dataset. Single interval 2σ range calibration values are expressed for intercepts representing ≥0.95 of the relative area under the probability distribution. If relative area is ≥0.1, that value is listed in parentheses. In cases of multiple intercepts, the 2σ ranges with relative areas under the probability distribution of ≥0.05 are noted in parentheses for intercept separations of ≥20 y. Age ranges are rounded to the nearest 5-y increment.

Mono B. This U-shaped mound measures ∼20 × 23 m with the short axis oriented at 294° ± 2°. The east–west axis of the mound precisely aligns with the June solstice (Fig. S2). Excavations uncovered a profile of clean fill with three distinct floors. A vegetal matter layer was placed at the base of these floors, similar to Mono A. Table 1 shows radiocarbon dates from this profile. We collected two samples of cane and maize leaves [University of California Irvine (UCI) AMS-131969 and -131970] at the base of the most recent wall, from both sides of the unit. These samples produced nearly identical 2-sigma–calibrated dates of 360–205 BCE. The second floor sampled (UCIAMS-131971) was also found to be contemporary with the higher levels. The deepest level produced a date that overlaps significantly with the upper levels, indicating (with a very high degree of probability) that the entire mound was built in one construction episode between 360 and 210 BCE. Mono B is therefore later in date than Mono A and C. Unlike Mono A, it does not have a domestic component.

Mono C1. This platform mound is ∼22 × 36 m with the long axis oriented at 280° ± 2°. All visible walls on the surface and in excavation units are oriented along 295° ± 2°. The walls therefore mark the June solstice. Previous excavations in a sunken court at the summit (8) uncovered Paracas materials of the Pinta substyle, contemporary with the Ocucaje 8 stylistic phase or approximately the 3rd century BCE in the traditional chronology (12). We excavated the outside southwest corner of the mound, near an intact visible wall. As seen in the profile (Fig. S3), we obtained five carbon samples at 40, 55, and 110 cm below datum. The data indicate with a ≥0.95 probability that the entire structure was built between 410 and 225 BCE. Based upon samples UCIAMS-131976 and -131973, there is a high probability (≥0.92) that the mound was built in one construction episode between 410 and 355 BCE making it virtually identical in time to Mono A and earlier than Mono B. Mono C1 does not have a domestic component.

Mono C2 is an irregular-shaped mound about 23 by 30 m at its base. It contains a long rectangular structure that is oriented to the June solstice. Connected to this rectangular mound is a U-shaped section, facing the June solstice. We did not excavate this structure.

Mono C3 is a rectangular mound ∼12 × 20 m. The long axis of the structure is oriented along 280°. All visible walls on the surface are oriented at ∼295° ± 2° and therefore mark the June solstice. We did not excavate this structure.

Discussion

These results have three important implications for understanding early political complexity on the south coast of Peru.

The Pre-Nasca Date of the Chincha Geoglyphs. Dating geoglyphs can be difficult. Both additive geoglyphs (lining up or piling rocks) and subtractive ones (removing stone and clearing soil to the desert pavement) almost always lack the intact organic material necessary for radiocarbon dating (Fig. S7). In the case of Nasca, researchers have used a variety of methods to circumvent this problem (13). A few Paracas geoglyphs exist in the coastal valleys from Chincha to Nasca, particularly in Palpa where anthropomorphic geoglyphs date to the late Paracas period (14). The bulk of the linear geoglyphs, in contrast, date to the Nasca period (CE 1–600) in the Nasca and Palpa Valleys, with an occasional outlier both earlier and later (9, 11, 15, 16). These dates correspond to the apogee of Nasca society in the Nasca drainages.

Because the Chincha lines integrate so nicely with Paracas ceremonial mounds and sites, they can be indirectly but securely dated by association with these datable features. All five settlements in the study area, by association with pottery styles, date to the Late Paracas period circa 400–100 BCE (1, 7, 8, 17). The one exception is PV57–64 where there is both a significant late Paracas component as well as a Nasca-contemporary Carmen occupation (17). Excavations by our team in the main sunken patio of PV57–59 (Cerro del Gentil) recovered only late Paracas materials, with a later superficial squatter occupation dating to the Carmen phase (ca. CE 200–500). The patio was not used in the Carmen period. A previous survey reports that PV57–60, now a modern quarry, is predominantly Paracas in date (1). Our own observations of in-situ late Paracas ceramics from exposed profile cuts corroborate these earlier observations. PV57–136 is now largely destroyed except for some large stone foundations. This site was identified in the 1980s as a Paracas site (4), but little other information is available today. In short, the principal occupations of the five sites that comprise the middle valley cluster are securely Late Paracas in date.

The bulk of the construction at PV57–63 is Paracas in date, including the entire pyramid mound complex. Excavations in Mono A indicate a shallow and very late occupation (14th century CE) on top of a very large Paracas period platform mound and sunken patio complex. This scenario is similar to that found in our ongoing excavations at PV57–59 (Cerro del Gentil). Excavations at PV57–63 in the 1980s confirmed this chronology (8). The mounds of Mono B and Mono C, in contrast, provide the strongest individual evidence of a Paracas date for the linear geoglyphs. The lines are single construction episodes that are closely integrated with Paracas platform mound sites, leading us to conclude that they date solely to the Paracas period in Chincha. The Mono B and C mounds were built and used as a center of social activity in conjunction with the linear geoglyphs. Finally, all sites that are visually framed by sets of geoglyphs have Paracas-associated occupations as their principal component.

The Integration of Lines, Sites, and Ceremonial Mounds. We have demonstrated that most of the lines discovered in Chincha are visually and physically integrated with specific settlements or with solstice alignments. Before our research there were hints that such a pattern existed, based upon earlier observations in the south that showed integration of major Nasca period (CE 1–600) sites and geoglyphs. The intensive subsequent use of these landscapes during later Nasca times perhaps obscured much earlier evidence. Lambers and Sauerbier, for instance, report that geoglyphs "integrated" portions of settlements in their study region in Palpa (18). Reindel and Isla discovered trapezoidal geoglyphs that converged on a common area at the site of Los Molinos (19). In other areas, particularly Nasca, this pattern is rarely found. Aveni (9) argues that the "ray centers" (similar to the cluster of lines southeast of PV57–64) were homologous to the complex cosmological ordering system of the Inca (CE 1450–1532), known as the *ceque*. In this case, linear geoglyphs either converged on or radiated out from (depending on your perspective) a landscape feature, such as a hill. In either case, they served to mark a culturally significant spot on the landscape.

Winter Solstice Marking Was an Important Component of Geoglyph and Ceremonial Mound Construction. Mid-to-late 20th century studies of the famous Nasca geoglyphs focused heavily on celestial alignments (20). The "calendrical" model—the idea that the Nasca pampa constituted a complex system of time keeping based on astronomical observations— remains largely unsupported, although its proponents did identify a few geoglyph features as marking solstice events (21). Elsewhere in the Andes, research demonstrates that pre-Hispanic peoples actively marked solstices and other cyclical astronomical occurrences. Recent work at the fortified site of Chankillo on the northern Peruvian coast uncovered a series of 13 carefully placed stone towers, some of which correspond to annual solstice and equinox events (22, 23). Chankillo is roughly contemporary with the Paracas phases we report on here for Chincha. Benfer describes a number of solstice alignments in early mound structures elsewhere on the northern Peruvian coast, dating to the late third and early second millennium BCE (24). Historical and archaeological data indicate that the Inca Empire marked the movement of the sun with paired stone pillars placed on the hills surrounding Cusco (25, 26). The marking of the winter solstice during the Inca period has been confirmed on the Island of the Sun in the highland Titicaca Basin (27).

In Chincha, linear geoglyphs, platform mounds, and walls on those ceremonial mounds mark the June solstice. If it were only lines, then one could argue that the few solstice alignments were due to chance. However, the combination of platform mounds built in orientation with the June solstice, similarly positioned wall alignments, and comparative evidence from other regions in the Andes that documents solstice marking at sites contemporary with the Paracas period, makes purposeful construction the most parsimonious explanation. Based on these data, there is little doubt that marking the June solstice is an Andean tradition that was part of the logic of ceremonial mound construction and the creation of linear geoglyphs in pre-Hispanic Chincha during Paracas times.

Conclusion

In light of these data, we maintain that geoglyph building, much like architecture or pottery, is a social technology that can be used for diverse purposes. The attempt to find a single function is futile. The data from Chincha indicate that these particular geoglyphs (and associated mounds) were used to mark time and attract participants to attend a recurring set of social events. They also mark special places on the landscape for those events, some sacred, some secular. Similar to historically documented Inca towers, there is a specific period that was important to late Paracas people. Alongside nondomestic mounds and stone platforms, the linear geoglyphs formed a coherent ritualized landscape that structured those events. The lines integrated domestic and ceremonial areas within a larger desert landscape, and they focused significant social activities onto this otherwise unproductive zone between the highlands and the coast.

The placement of the Chincha lines is generally consistent with pilgrimage models of cyclical social movement in the Andes (9, 10, 28). Our findings support Vaughn's model that production, exchange and "materialized ideologies" were significant factors in the development of political authority in the Andes in general, and among the Paracas and Nasca peoples in particular (29). It likewise fits Van Gijseghem and Vaughn's characterization of the geoglyph technology as a means of social integration (30). Consistent with this broad theoretical framework, we suggest that the creation of a modified and ritualized landscape was a strategy used by people living primarily in large platform mound complexes of the lower valley. Leaders in these lower valley political centers demarcated places and times for interregional interaction between highlanders and coastal populations. The optimal location for this interaction was in the vacant desert plains above the valley floor in this intermediate "chaupiyunga" zone (31). Ritualized movements and astronomically defined schedules encouraged and fomented this interaction. The ritualized landscape publically attested to particular platform mound sites as focal points for social gatherings, but it was also a product of these gatherings. The act of creating geoglyphs within the broader ritualized landscape—the physical piling and clearing of rocks and soil—may be a key component of individual participation in such events. The specific nature of these social events remains obscure and will be the focus of our future research.

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